

OPTICAL DISK CONTROLLER AND
OPTICAL DISK DEVICE

BACKGROUND OF THE INVENTION

5 The present invention relates to an optical disk controller that performs processing such as modulation on a signal obtained from a pickup by reading data recorded on an optical disk.

10 In recent years, development of optical disk devices for DVD-ROMs, DVD-RAMs, in succession to those for CD-ROMs, has made progress. Many of such optical disk devices are implemented by the combination of an optical disk controller that performs a series of data processing including modulation, error correction, buffering, and transfer to host and a system controller that controls components of the optical disk
15 device such as a pickup and a servo.

20 Figure 10 shows an optical disk device including a conventional optical disk controller. Referring to Figure 10, the optical disk device includes: a spindle motor 101 for rotating an optical disk 100; a pickup 102 for reading data from the optical disk 100 by radiating the optical disk 100 with laser light; a servo 103 for positioning the pickup 102; an optical disk controller (ODC) 710 for performing signal processing; and a system controller 720 for controlling the
25 operation of the entire system.

The optical disk controller 710 includes a command interpreter 711, a demodulator 712, an error correction section 713, a data buffer 714, a host interface 715, and a status generator 716.

5 A host PC 730 sends a command to the optical disk device requesting data read from the optical disk 100. On receipt of the data read command via the host interface 715, the system controller 720 controls the spindle motor 101 to rotate the optical disk 100 and the servo 103 to move the pickup 102
10 to a target sector. The system controller 720 then issues command READ to the optical disk controller 710.

On receipt of the command READ, the command interpreter 711 instructs the demodulator 712 to read specified sectors. The demodulator 712 monitors data read by the
15 pickup 702 and, when recognizing data of a head sector, sends the data of the sector to the error correction section 713. The error correction section 713 executes error correction for the data output from the demodulator 712. The error-corrected data is then temporarily stored in the data
20 buffer 714.

The status generator 716 generates a status report or "status" for the data based on the error correction results received from the error correction section 713. Figure 11 shows examples of generated status reports, each of which is
25 composed of items of information category, factor, and auxil-

ary information. The information category indicates whether the issued command was "continued", "normally ended", or "abnormally ended". The factor indicates the state of the current sector. If any problem arises, information on the
5 problem is added to this item. The auxiliary information includes the current sector ID and the buffer page number on which the error-corrected data has been stored.

The status generator 716 generates a status report every time data of each sector is read, and outputs the results to
10 the system controller 720. The factor of the status report is "normal" for the sector of which data has been normally corrected. For the sector of which data has failed to be normally read during reading of the sector, the factor of the status report includes relevant information, so that the sys-
15 tem controller 720 is notified of the information.

Thus, the optical disk controller 710 generates the status report representative of the inner state thereof every error correction, thereby enabling the system controller 720 to keep track of the operation of the optical disk control-
20 ler 710. Based on the status report received, the system controller 720 can determine whether read operation be continued or aborted. In this way, proper read processing is realized.

In optical disk devices, one of factors for determining
25 drive performance is the rotational speed of the disk. As

the rotational speed of the disk is higher, the data read/write time is shorter and the data processing size per unit time is greater. Therefore, nowadays, operation at a higher rotational speed is requested for optical disk devices.

In the conventional status report output procedure, as the rotational speed of the disk is higher, the period of status report output becomes shorter. This reduces the time allowance given for determining whether the processing be continued or aborted based on a received status report after the status report is received. Consequently, as the rotational speed of the disk increases, the burden of the system controller becomes excessively large.

SUMMARY OF THE INVENTION

An object of the present invention is providing an optical disk controller that reduces the frequency of output of status reports to relieve the burden of a system controller.

Concretely, the optical disk controller for performing signal processing for an optical disk according to the present invention includes: a status generator for generating status reports each representing the operation state of the optical disk controller; and a status sampling section for sampling the status reports.

According to the invention, the status reports generated

by the status generator are sampled by the status sampling section. By this sampling, the frequency of output of status reports becomes lower than the frequency of generation of status reports, resulting in relieving the burden of a system controller that performs processing for the respective status reports.

Preferably, the status sampling section includes a sampling interval setting portion for setting a status sampling interval.

Preferably, also, the sampling interval setting portion sets the sampling interval according to the rotational speed of the optical disk. By this setting of the sampling interval according to the rotational speed of the optical disk, the burden of the system controller that performs processing for the respective status reports is avoided from increasing even when the rotational speed of the optical disk is enhanced. Preferably, the sampling interval setting portion determines the rotational speed of the optical disk according to a synchronization period of a signal demodulated from the optical disk.

The optical disk controller may further includes assigning means for allowing the sampling interval setting portion to set the sampling interval according to a command input externally.

Preferably, the sampling interval setting portion sets

the sampling interval according to an error rate of a signal demodulated from the optical disk.

The status sampling section preferably includes a sampling category storing portion that stores "sampling abort" status indicating that sampling operation should be aborted, and, when the status report generated by the status generator matches with the "sampling abort" status stored in the sampling category storing portion, the sampling is aborted.

The status sampling section preferably includes a sampling category storing portion that stores "forced sampling" status indicating that the status report should be output even during sampling operation, and, when the status report generated by the status generator matches with the "forced sampling" status stored in the sampling category storing portion, the status report is output even during sampling operation.

The optical disk controller may further include assigning means for setting sampling category information representing the relationship between a factor in the status report and sampling operation and storing the sampling category information in the sampling category storing portion. The status sampling section may update the sampling category information stored in the sampling category storing portion according to a signal demodulated from the optical disk.

It is also an object of the present invention to provide

Figure 11 shows an example of conventional status report output results.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings.

Figure 1 illustrates an optical disk device 1 including an optical disk controller of an embodiment according to the present invention. Referring to Figure 1, the optical disk device 1 includes a spindle motor 101 for rotating an optical disk 100; a pickup 102 for reading data written on the optical disk 100; and a servo 103 for positioning the pickup 102. An optical disk controller (ODC) 200 performs signal processing for the optical disk 100. A system controller 300 controls the entire optical disk device. A host PC or AV decoder 2 sends a command to the optical disk device 1 and receives data from the optical disk device 1.

The internal construction of the optical disk controller 200 will be described. The optical disk controller 200 may be implemented as LSI, for example.

A demodulator 201 demodulates a signal read from the optical disk 100. An error correction section 202 corrects error data included in the data demodulated by the demodulator 201. The error-corrected data is temporarily

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stored in a data buffer 203. The data stored in the data
buffer 203 is output to the host PC or AV decoder 2 via a
host interface 204. The demodulator 201, the error correc-
tion section 202, and the host interface 204 are implemented
5 by hardware, for example. The data buffer 203 is implemented
by DRAM, for example.

A status generator 210 generates a code, i.e., a status
report, indicating the operation state of the optical disk
controller 200. A status sampling section 220 samples status
10 reports generated by the status generator 210 and outputs
sampled status reports to the system controller 300. A com-
mand interpreter 230 as an assigning means interprets com-
mands sent from the system controller 300 and controls
activation of the demodulator 201 and the like, for example.
15 The status generator 210, the status sampling section 220,
and the command interpreter 230 are implemented by a combina-
tion of a microcomputer and a program, for example.

The status sampling section 220 includes a sampling in-
terval setting portion 221, a sampling determination por-
20 tion 222, and a sampling category storing portion 223. The
sampling interval setting portion 221 sets the sampling in-
terval of status reports and holds the set sampling interval.
In this embodiment, the rotational speed of the optical
disk 100 is obtained from the synchronization period of the
25 signal demodulated by the demodulator 201, and the sampling

to the subsequent values of sampling interval) and terminate the operation.

Step S04: Proceed to step S05 if the rotational speed is octuple or lower, or otherwise proceed to step S06.

5 Step S05: Set the sampling interval at "8" and terminate the operation.

Step S06: Proceed to step S07 if the rotational speed is 16 times or lower, or otherwise proceed to step S08.

10 Step S07: Set the sampling interval at "16" and terminate the operation.

Step S08: Set the sampling interval at "20" and terminate the operation.

15 Figures 5 and 6 are a flowchart showing the operation of the sampling determination portion 222. The processing at each step shown in Figure 5 is as follows.

Step S11: Obtain sampling category information from the sampling category storing portion 223.

20 Step S12: Determine whether or not the status report generated by the status generator 210 corresponds to "sampling abort" status. If yes, proceed to step S13. Otherwise, proceed to step S14.

Step S13: Set a sampling execution flag FLG at "0" and proceed to step S21 (Figure 6).

25 Step S14: Determine whether or not the status report generated by the status generator 210 corresponds to "forced sam-

pling" status. If yes, proceed to step S15. Otherwise, proceed to step S21.

Step S15: Set a sampling counter CT at "0" and proceed to step S21.

5 The processing at each step shown in Figure 6 is as follows.

Step S21: Determine whether or not the sampling execution flag FLG is "0". If "0", proceed to step S22 for aborting the status sampling. If not, proceed to step S23 for executing status sampling.

Step S22: Output the status report generated by the status generator 210 to the system controller 300 and terminate the operation.

Step S23: Determine whether or not the sampling counter CT is "0". If "0", proceed to step S24 since the current status report generated by the status generator 210 should be output. If not, proceed to step S25 since the current status report should be omitted.

Step S24: Output the current status report generated by the status generator 210 to the system controller 300.

Step S25: Increment the value of the sampling counter CT by "1".

Step S26: Compare the value of the sampling counter CT with the sampling interval received from the sampling interval setting portion 221. If these values match with each other,

proceed to step S27. If not, that is, if the value of the sampling counter CT has not reached the sampling interval, terminate the operation.

Step S27: Set the sampling counter CT at "0".

5 Hereinafter, the operation of the optical disk controller of this embodiment with the above construction will be described in a concrete manner. Assume herein that the optical disk 100 has a sector arrangement as shown in Figure 7. That is, as is seen from Figure 7, the data category has
10 changed in sector 752 and sector discontinuation has occurred in sector 756.

The host PC or AV decoder 2 sends a command to the optical disk device 1 requesting to read data from the optical disk 100. The command is received by the system controller
15 ler 300 via the host interface 204.

The system controller 300 issues command SAMPLING VALID to the command interpreter 230. The system controller 300 also issues command STATUS CONDITIONS to the command interpreter 230, in which "sampling abort" is set for a status report having the factor "sector discontinued", and "sampling
20 target" is set for a status report having the factor "correction not permitted" or "error rate increased". The system controller 300 further issues command ODC OPERATION MODE: FOR VIDEO/AUDIO REPRODUCTION to the command interpreter 230.

25 The system controller 300 then instructs the spindle mo-

tor 101 to rotate the optical disk 100 and the servo 103 to move the pickup 102 to a target sector.

On receipt of the command SAMPLING VALID, the command interpreter 230 sets the sampling execution flag FLG of the sampling determination portion 222 of the status sampling section 220 at "1". A signal read by the pickup 102 is sent to the demodulator 201, which measures the period of one sector and determines the rotational speed as octuple. On receipt of the information from the demodulator 201 that the rotational speed of the disk 100 is octuple, the sampling interval setting portion 221 sets the sampling interval at "8".

On receipt of the command STATUS CONDITIONS, the command interpreter 230 sets sampling category information and stores the results in the sampling category storing portion 223. Stored in the sampling category storing portion 223 is sampling category information as shown in Figure 8 in this embodiment, which represents the relationship between the factor in the status report and the corresponding sampling operation. Concretely, "sampling abort" is designated for the factor "sector discontinued", "sampling target" is designated for the factors "error rate increased" and "correction not permitted", and "forced sampling" is designated for the factor "data category changed". For the other factors, "sampling target" is designated.

The system controller 300 issues command READ: SECTOR TO

the status generator 210. Being informed of a change in data category by the data buffer 204, the status generator 210 generates the status report "sector: 752 / data category changed" for sector 752.

5 On receipt of the status report for sector 752 "sector: 752 / data category changed" generated by the status generator 210, the sampling determination portion 222 operates according to the flowchart shown in Figures 5 and 6.

First, the sampling determination portion 222 retrieves
10 the sampling category information representing the relationship between the factor in the status report and the corresponding designated sampling operation from the sampling category storing portion 223 (step S11). Since the status "sector: 752 / data category changed" is not "sampling abort"
15 status, that is, does not have the factor "sector discontinued" (step S12), the process proceeds to step S14. Since the status "sector: 752 / data category changed" is "forced sampling" status, the value of the sampling counter CT is set at "0" at step S15.

20 At step S21, since the sampling execution flag FLG is "1" indicating that sampling is to be executed, the process proceeds to step S23. At step S23, since the sampling counter is "0" indicating that the status report is to be output, the status report "sector: 752 / data category
25 changed" is output to the system controller 300. At step S25,

the value of the sampling counter CT is incremented by "1".
At step S26, the value of the sampling counter CT is compared
with the sampling interval ("8" in this embodiment) received
from the sampling interval setting portion 221. Since the
5 value of the sampling counter CT is "1", which is smaller
than the sampling interval, the operation is terminated.

On receipt of the status "sector: 752 / data category
changed" from the status sampling section 220, the system
controller 300 determines whether the read operation be con-
10 tinued or aborted. Assume in this case that the read opera-
tion is continued.

Next, sector 753 is read. The sampling determination
portion 222 receives the status report for sector 753 "con-
tinued / normal / sector: 753" generated by the status gen-
15 erator 210. This status is determined as "sampling target",
and the value of the sampling counter CT is "1". Therefore,
sampling of this status report is omitted. Subsequently,
sector 754 is read. The sampling determination portion 222
receives the status report for sector 754 "continued / normal
20 / sector: 754" generated by the status generator 210. This
status is determined as "sampling target", and the value of
the sampling counter CT is "2". Therefore, sampling of this
status is omitted.

Sector 755 is then attempted to be read but found miss-
25 ing. The demodulator 201 therefore determines as "sector

discontinued", and proceeds to read the next sector 756. The status generator 210 is informed of the "sector discontinued" by the demodulator 201, and generates the status report "sector: 756 / sector discontinued" representing that sector 756 is "sector discontinued".

On receipt of the status "sector: 756 / sector discontinued" generated by the status generator 210, the sampling determination portion 222 operates according to the flowchart shown in Figures 5 and 6.

First, the sampling determination portion 222 retrieves the sampling category information representing the relationship between the factor in the status report and the corresponding designated sampling operation from the sampling category storing portion 223 (step S11). Since the status "sector: 756 / status discontinued" is "sampling abort" status, that is, has the factor "sector discontinued" (step S12), the process proceeds to step S13. At step S13, the sampling execution flag FLG is set at "0", and process proceeds to step S21.

At step S21, since the sampling execution flag FLG is "0", it is determined that the sampling is aborted. The status report "sector: 756 / status discontinued" is output to the system controller 300 (step S22), and the operation is terminated.

At the above point, the sampling execution flag FLG was

set at "0" indicating that the status sampling is aborted. Therefore, this status report "sector: 756 / status discontinued" and all the subsequent status reports are sent to the system controller 300 without sampling. That is, as for sectors 757 and 758 to be subsequently read, generated status reports are output without sampling.

Figure 9 shows the results of the above sampling. The system controller 300 has received only the status reports shown in Figure 9. In other words, the status reports for sectors 751, 753, and 754 were omitted in the sampling. The status report for sector 752 which would have otherwise been omitted was output because it had the factor "data category changed". Also, since sector 755 was missing, the status report for sector 756 that had the factor "sector discontinued" was determined as "sampling abort" status. By this determination, all the status reports for sector 756 and the subsequent sectors were output.

Thus, as described above, the optical disk controller 200 executes sampling of status reports to be output to the system controller 300 while selectively outputting important information during the sampling. This reduces the data amount of status reports the system controller 300 must handle individually to provide determination. Therefore, the number of status reports is prevented from simply increasing when the rotational speed of the optical disk 100 is enhanced,

as in the conventional case. As a result, the burden of the system controller 300 is relieved.

In the above embodiment, the status report was generated on the premise that one error correction corresponds to one
5 sector. The present invention is also applicable to other cases, for example, the case where one error correction corresponds to 16 sectors.

In the above embodiment, the sampling interval setting portion 221 set the sampling interval according to the syn-
10 chronization period of a signal read from the optical disk 100. The setting of the sampling interval may also be made in other ways. For example, the sampling interval may be set according to the error rate of a signal read from the optical disk 100. Alternatively, the command interpreter 230
15 as an assigning means may specify the sampling interval according to a command supplied from the system controller 300.

In the above embodiment, the command interpreter 230 as an assigning means set the sampling category information representing the relationship between the factor in the status
20 report and the corresponding sampling operation according to a command from the system controller 300, and stored it in the sampling category storing portion 223. The sampling category information stored in the sampling category storing portion 223 may further be updated according to the synchro-
25 nization period, the error rate and so forth of a signal de-

modulated from the optical disk 100.

In place of the sampling category information representing the relationship between the factor in the status report and the sampling operation, the categories of "sampling
5 abort" status and "forced sampling" status may be stored in the sampling category storing portion 223.

While the present invention has been described in a preferred embodiment, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than that
10 specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the invention that fall within the true spirit and scope of the invention.

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